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Issued June 7, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE.
GIFFORD PINCHOT, Forester.

INSTRUCTIONS FOR THE BUILDING AND MAINTENANCE OF TELEPHONE LINES ON THE NATIONAL FORESTS.

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CONTENTS.

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INTRODUCTION.

Telephone lines on and near the National Forests assist in their protection and administration and make the Forests more useful to the communities whose interests they are to serve. The Forest Service will build telephone lines only where they are necessary for protective or administrative purposes, and then only where there is insufficient business to warrant commercial companies in constructing lines. Commercial companies and settlers should be encouraged to build lines on and near the Forests, and the Service will cooperate with them so far as possible, with the understanding that it shall have free use of such lines for official business. For the most part the lines of the Forest Service will be branches connecting supervisors' and rangers' headquarters with exchanges of commercial companies. The lines of the Service must necessarily be of simple and cheap construction at first. The main thing is to get ready means of communication. This done, the equipment will be improved as fast as possible. The usual construction will be a one-wire line on brackets attached to poles or trees. For distances up to 70 miles No. 12 B. W. G. Best-Best galvanized-iron wire should be used, and for greater distance No. 9 wire should be used.

LOCATING.

The location of the line should conform as closely as may be to the following conditions. The line should—

(1) Pass near lookout points, where they exist.

(2) Follow roads and main trails.

(3) Be direct, consistent with the above.

(4) Avoid steep slopes, cliffs, etc., and streams or canyons over 500 feet across.

(5) Avoid power and transmission lines as far as possible.

If any part of the line is off the Forest, right of way must be obtained, drawn up on a regular form, which will be furnished by the District Forester on request. A survey of the line may or may not be necessary. The line should be carefully laid out, however, by the foreman in charge of the work and stakes set showing the proper location of poles.

ATTACHING WIRE TO TREES.

In the construction of tree lines, care should be exercised in selecting only sound trees with a diameter not less than 4 inches at the

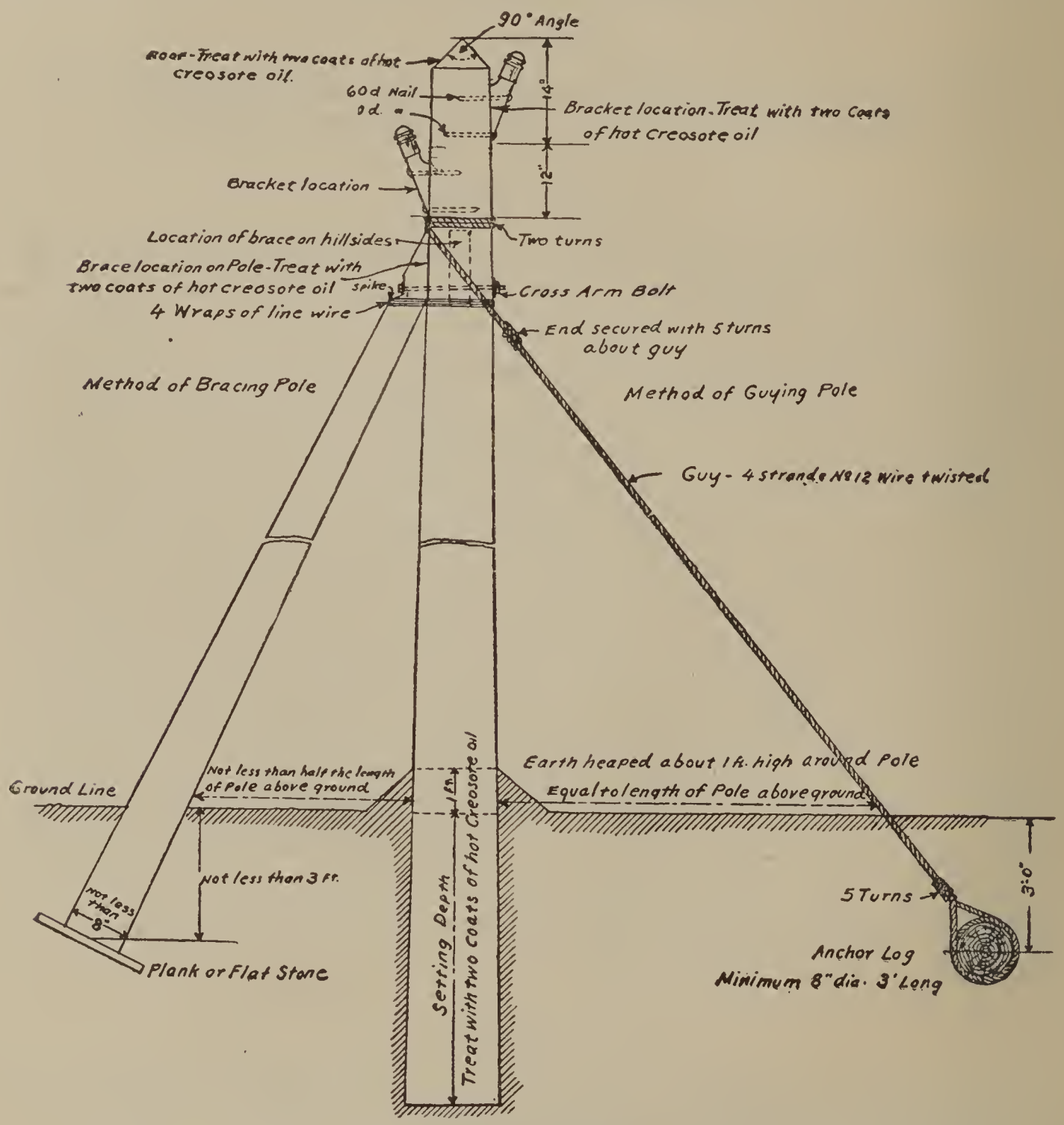

FIG. 1.—Diagram showing method of setting, guying, and bracing pole and locating brackets.

point where the bracket is to be attached. Avoid extremely large trees, since they are very difficult to climb, and being of a merchantable size, are more apt to be selected for cutting in the near future. The course of the line may be varied considerably in order to make use of trees where, in the opinion of the officer in charge, the cost of construction will thereby be lessened.

CLEARING RIGHT OF WAY.

A right of way wide enough for a bridle trail should be cleared when the line runs through dense underbrush or chaparral; all leaning trees, or limbs of trees, hanging over the cleared right of way which would be likely to swing and catch, or rub against the wire, or which may be borne down upon the line by weight of snow or sleet in the winter, should be cut. In other words, anything that would at the present, or in the very near future, cause trouble on the line should be cleared before or at the time the wire is being strung.

On account of the expense of clearing, the line should be run so far as possible to avoid heavy clearing, but at the same time not at the sacrifice of the proper location of the line.

All trees to be used in place of poles should be trimmed so that no limbs will touch the wire, either at the time the line is built or when weighted with snow or sleet. Where the tree to be used is larger than 4 inches in diameter at the point where the bracket will be attached, it should be trimmed up 4 feet above the bracket, otherwise only enough to clear the wire of all limbs.

CUTTING, SEASONING, AND TREATING POLES.

CUTTING POLES.

All poles should be cut from live or *sound* dead standing trees, and should be free from butt rot or other defects which would weaken the pole. They should be reasonably straight, peeled, with branches trimmed close, and of the following sizes:

Length.	Top diameter.
Feet.	*Inches.*
18	5
22	5
25	$5\frac{1}{2}$
30	6
35	6

They should be cut as near the place where they are to be set in line as is practicable, but at the same time it should be kept in mind that it is desired to use the best timber obtainable at a reasonable cost, such as red cedar, white cedar, and tamarack. In some cases it may be desirable to purchase poles, when the cost at the hole will be lessened, or when a better pole can be obtained than can be secured locally from the National Forest. When possible, poles and braces should be cut in winter. They should be peeled as soon as cut and all knots trimmed close. The butts of the poles should be cut off square and the tops cut slanting on both sides to form a right-angle "roof." (See fig. 1.)

SKIDDING AND SEASONING.

When a number of poles or braces can be collected at one point as they are cut, and can be distributed along the line at the time of building, without undue expense, they should be piled tier upon tier with a space of at least 6 inches between poles in the same tier and between tiers. The bottom tier should be of sufficient height from the ground to allow of the free circulation of air under the poles. They should be seasoned at least two months and as much longer as possible.

When it is not feasible to collect poles or braces at one point they should be peeled and raised off the ground or leaned against trees or rocks in an open position to season. If sound dead timber is available, it is to be preferred, because it will not be necessary to season it.

TREATING.

After seasoning, poles and braces should be treated with coal-tar creosote[a] according to the following directions:

Heat the creosote in an iron pot to about 175° F., being careful that the temperature does not at any time exceed 200° F. or fall below 150° F.

Apply the hot creosote, with iron-bound brushes 4 to 5 inches wide, to the outside of the pole from the butt to a point at least 1 foot above the ground line when the pole is set. Take particular pains to fill all seasoning checks and knot holes. After an interval of at least twenty-four hours the pole should be treated with a second coat applied in the same manner. The top of the pole and the places where the brackets and braces will be attached should also be treated with two coats of hot creosote. (See fig. 1.) The preservative should never be applied when the surface of the pole is wet from rain, snow, or frost, or when the pole is frozen.

Braces should be treated in the same manner as poles, and in addition two coats of hot creosote should be applied to the slanting top which is to rest against the pole.[b]

Where very few poles are set on a line and only to fill in gaps between trees, or on short branch lines connecting with another, where the length is not greater than 2 or 3 miles, it is not necessary to treat them. If the branch lines are constructed at the same time as the main line, the poles should, of course, receive treatment. The life of cedar poles can be prolonged approximately three years by the treatment, but redwood poles do not need it. Care must be exercised

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[a] Creosote can usually be bought to the best advantage through the district office.

[b] Under no circumstances should green timber be treated with preservatives applied with brushes to the outside, since such treatment is seldom effective and in most cases even hastens decay.

in this work. Some forethought must be used in deciding on preservative treatment, since it is desired to treat poles only where it is good common-sense business policy.

BUILDING DIRECTIONS.

LENGTH OF POLES.

The standard pole is 22 feet long and should be used in all but special cases, where longer poles, of lengths to be determined when locating the line, should be used. In case 22-foot poles are not available and shorter poles are, the shorter ones may be used, but only with the approval of the District Forester.

The special cases where poles longer than 22 feet will be used are as follows:

(*a*) Where the underbrush exceeds 10 feet in height, use poles that will keep the lowest wire at least 4 feet above the highest brush at the middle of the span.

(*b*) Where snow is liable to drift to depths exceeding 10 feet, use poles that will keep the lowest wire at least 2 feet above the maximum depth of the drift at the middle of the span.

(*c*) Where it is necessary to grade the line to overcome abrupt changes in level.

(*d*) Where the line crosses wagon roads or railways, use poles that will keep the lowest wire at least 14 feet above the road and 26 feet above the railway at the middle of the road or track, unless otherwise required by State laws.

(*e*) At the ends of long spans across rivers, canyons, etc. Special poles or construction to be determined by the District Forester will be used at these points.

DISTRIBUTION OF POLES.

Place poles as near as possible to the holes where they are to be set. Poles between the minimum and average size should be used on straight sections; poles above average size should be used on curves, at corners, and at the ends of long spans; extra strong poles must be used in exposed positions and where there is danger of heavy storms.

SPACING.

On straight sections poles should be set 176 feet apart, which will give 30 poles per mile. Where it is necessary to make any change in the direction of the line, care should be taken to make the change gradually by spreading the curve over as many poles as possible. If sharp bends are unavoidable, proper guys or braces, or both, must be provided. On curves and corners where the pull is from 10 to 30 feet the pole spacing should be 100 feet. (By the term "pull" is

meant the distance *a*, fig. 2.) Where the pull is over 30 feet, the turn should be made on two poles.

At right-angle corners the section on either side next to the corner pole should not be over 100 feet in length. Next to spans of from 200 to 250 feet the sections at both ends will be 100 feet.

On spans from 250 to 500 feet, two sections on both ends should be 100 feet. On spans above 500 feet, special construction, to be determined by the District Forester, should be used.

On steep slopes sections will be so proportioned as to avoid abrupt changes in the level of the wire. Thus it follows that, where crossing a ridge where the slope at the top is steep, it is better to space the poles so that one is set on each side of the summit of the ridge than to set a pole on the top. This prevents a sharp angle in the line. If necessary, use long poles to obtain the desired clearance in the span.

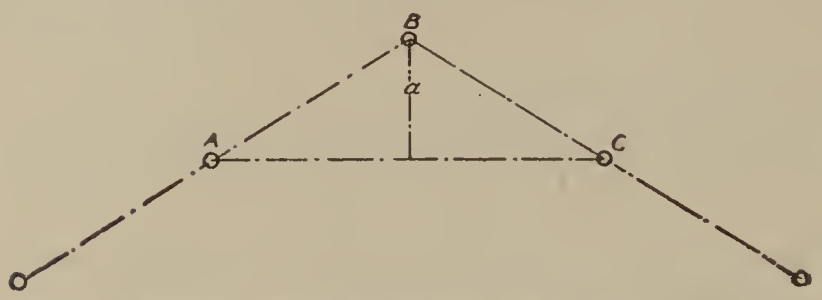

FIG. 2.—Diagram showing method of determining "pull" at corners.

DIGGING HOLES.

On straight sections holes should be dug straight and of full size from top to bottom, and at least 6 inches larger in diameter than the butt of the pole, so that the earth thrown in the hole may be evenly tamped around the pole for the total depth of the hole. They should be of the following depths:

Length of pole.	Depth of hole.	
	In earth.	In rock.
Feet.	*Feet.*	*Feet.*
18	3½	3
22	4	3
25	4½	3½
30	5	4
35	6	4½
40	6½	5

On the hillsides the depth of the hole should be measured from the lower side.

Where it is not possible to dig to the required depth, the pole should be securely braced or guyed, and stones and earth heaped around it and well tamped.

Where the line crosses solid rock for a distance of not more than 250 feet a span of that length may be used, but for greater distances it will be advisable to blast holes in which to set the poles. Where it is necessary to blast many holes, special construction, to be deter-

mined by the District Forester, may be resorted to, and instructions should be asked for before taking up the work.

In some such cases consider the use of 2½-inch gas-pipe poles, which may be clamped to the rock, or placed in holes drilled sufficiently large to receive the gas pipe, and thus render blasting unnecessary.

LIGHTNING RODS.

Lightning rods should be put on poles before they are set, and should be placed on every tenth pole, and at exposed points where crossing mountain ranges or divides a rod should be placed on every fifth pole. These rods should be made of the same wire as is used for the line, and attached to the poles in the following manner: Cut the wire sufficiently long to reach from 6 inches above the top of the pole to about 3 feet below the bottom, which will be sufficient to make a small coil of three or four turns, 5 or 6 inches across, at the bottom of (not around) the pole. The upper end of the wire should be bent about 6 inches from the end, and given several turns about itself. It should then be stapled to the pole with 1½-inch staples at a point one-fourth the distance around the pole from the bracket. The upper end should project about 3 inches above the top of the pole, and after the first staple has been driven the wire should be drawn tight and stapled at the bottom. Additional staples should be used at intervals of 3 feet. The wire projecting at the bottom should then be made into a coil as above described and held in place on the bottom of the pole with two or three staples.

SETTING POLES.

On straight sections poles are to be set vertically. Corner poles are to be raked (inclined) outward from the center when set. When the pull is less than 5 feet the rake should be about 10 inches; when the pull is 5 to 10 feet the rake should be about 15 inches, and when the pull is over 10 feet the rake should be about 25 inches.

FILLING AND TAMPING.

When the pole has been set in the hole it should be "trued" and held in position while the hole is being filled and the filling tamped. The filling should be done by one man, and the earth firmly tamped by two men. When the hole is filled, earth should be piled around the pole and firmly packed.

ATTACHING BRACKETS.

On one-wire lines brackets are to be placed on the same side as the "roof" slant, and on the same side of all poles in the line, except that a change of location may become necessary in order that all brackets

at angles, crossings, or curves will be on the side of the poles away from the direction of the strain, so that there will be no tendency to pull the insulators away from the poles.

They should be nailed to the pole with one 60-penny and one 40-penny galvanized nail at the places previously treated. The base of the upper bracket should be 14 inches below the top of the pole, and the base of the lower bracket 12 inches below the base of the upper. On straight sections of two-wire lines the brackets will be on opposite sides of the pole (see fig. 1), but on curves both brackets will be on the same side of the pole, away from the center of the curve. Brackets should be attached and insulators screwed on before the pole is erected.

Whenever a line crosses the tracks of a railroad company the first pole on each side of the track is to be double cross-armed and well guyed.

BRACING AND GUYING.

Braces are preferred to guys and should be used whenever possible. Braces or guys should be used on poles in the following positions:

(*a*) On curves or at corners where the pull exceeds 30 feet.

(*b*) At road crossings.

(*c*) The two end poles of spans between 200 and 250 feet.

(*d*) Two poles on either end of spans between 250 and 500 feet. (Special construction, to be determined by the District Forester, should be used at the ends of spans over 500 feet.)

(*e*) All poles on steep slopes where short sections are used. Anchor guys may preferably be used in these cases, or a head guy from the top of one pole to the base of the pole next above it may be used.

(*f*) Alternate poles in exposed positions.

(*g*) In swamps or on loose ground where necessary.

(*h*) Poles on both ends of power or transmission-line crossings. (Special construction, to be determined by the District Forester, should be used where telephone lines cross under or over power or transmission lines.)

Braces are preferred to guys where the cost of the braces when set in position will be less than that of guys. When an anchor guy is put up on a public highway or street in city or town, a guard of some kind should be wired to the anchor guy, in order that it may be easily seen. In the construction of lines, braces or guys should be used as follows:

Braces should be at least 8 inches in diameter at the butt and should be cut slanting at the top to fit close to the pole, but the pole must not be cut. They should set at least $2\frac{1}{2}$ feet in the ground; $3\frac{1}{2}$ feet would be better, if too much difficulty is not encountered in

digging. The bottom end of the brace should rest on a flat stone or piece of plank, preferably the former, if it can be readily obtained. The brace should be attached to the pole by first spiking with two 60-penny nails near the center and topmost part of the brace, then a $\frac{5}{8}$-inch hole should be bored through both the brace and the pole to go through just above the point where the brace and pole come together. (See fig. 1.) The brace should then be bolted to the pole with one $\frac{5}{8}$-inch machine bolt, one washer to be used on each end of the bolt.

Guys should be made of four pieces of the line wire twisted together, and should be long enough to reach from the top of the pole to the ground at a distance equal to the height of the pole above ground, with enough additional length to allow for the depth of the anchor holes, for wrapping the end of the guy twice around the pole, twice around the anchor log, and securing each end around the guy wire. After a guy is twisted up and ready to be put in place one end should be first wrapped around the anchor log twice and stapled; then the end twisted securely around the guy, to make five complete turns of the end around the guy proper. This can best be done by using a pair of connectors. After the five turns have been made around the guy the four wires should be separated from the end back to the last or fifth wrap, and these be twisted singly around the guy proper by using a pair of pliers. All four may be twisted tight around the guy three full turns each, then one cut off close and the three remaining ends given three more wraps around the guy and one more wire cut off close; the two remaining wires are then given two full wraps around the guy, one of these cut off as before, and the last wire given four full wraps around the guy and cut off close. This will finish up the end in a good, substantial manner, and if care is used the wires will not unwrap under any ordinary strain. The anchor log is then placed in the hole, and the earth well tamped as it is filled in. The anchor log should not be less than $3\frac{1}{2}$ feet nor more than $4\frac{1}{2}$ feet long, with a minimum diameter of 8 inches.

The other end of the guy wire is then taken up the pole. A sling is placed around the pole as near the top as possible, and one end of a pair of pulley blocks is hooked into it, and a Buffalo grip or a medium-sized Haven clamp large enough to receive the guy wire is attached to the other end. The guy is then pulled to the required tension to hold the pole in the desired position, and the end of the guy wire is wrapped around the pole twice just underneath the first bracket, and then given five full turns around the guy proper and the end finished up by separating and twisting the wires as previously explained.

STRINGING WIRE.

Wherever possible a reel containing as much wire as can be handled by two men should be carried along the line. Where there is dense underbrush or rough or precipitous country, and it is not possible to carry the reel, it should be left on the ground and the wire reeled off from it by being pulled through or over such places. It is best to reel off all the wire remaining, if it is possible to do so, in order to avoid making any unnecessary splices in the wire.

No more wire should be strung out during a day than can be put up and tied in during that day. Special care should be taken not to reel off wire and allow it to lie across trails or roads where it will be run over by teams or saddle animals; for, aside from the danger, if this happens in rocky or gravelly ground small kinks and nicks will be cut in the wire by the wheels of the vehicles or the animals' shoes, and while the wire may not break at that time it will be weakened sufficiently to break as soon as a little strain is put upon it or when it contracts in cold weather. Care must be taken that all kinks, if there be any in the wire, are straightened before it is stretched.

For spans up to 500 feet the line wire may be used. Where spans of over 500 feet occur, instructions from the District Forester should be asked for in advance, in every case giving the length of span required and the approximate height from water surface or bottom of canyon to a straight line between supports.

JOINING WIRE.

In the construction of all lines in the future the joints in the wire should be made by the use of McIntire sleeves (see *A* and *B*, fig. 3), but in cases where it may be impossible to secure the McIntire sleeves, the Standard Western Union joint (*C*, fig. 3) may be used.

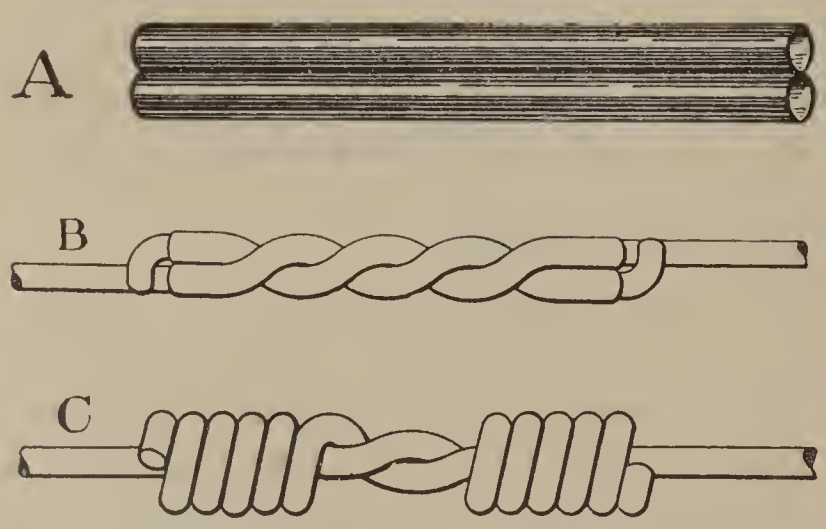

FIG. 3.—Method of joining wire. A—McIntire sleeve before using; B—McIntire sleeve after using; C—Standard Western Union joint.

The McIntire sleeve makes a much closer joint, and there is, therefore, better contact and less leakage than when the ordinary joint without sleeves is used. McIntire sleeves of galvanized iron should be used when the line is constructed of iron wire, and copper sleeves should be used when the line wire is of copper. A McIntire sleeve consists of two small tubes $4\frac{1}{2}$ inches long brazed together. The inside diameter of each tube is slightly larger than the diameter of the wire which is used. For that reason it is necessary to specify the

size of wire which will be used in the line in order that the proper size sleeve may be obtained.

The method of joining when the sleeve is used is as follows: One end of the wire to be joined is passed through one of the tubes so that approximately 1½ inches of the end of the wire project from the tube; the other wire is brought in from the opposite direction through the other tube with the same amount projecting. A pair of reversible connectors of the 309 type are then placed on each end of the sleeve, and it is twisted tight, which will require about two and one-half full turns; then the projecting ends of the wire are twisted once around the line wire and cut off close to it.

TYING IN WIRE.

In starting to tie in a line, the end of the wire at the starting point should first be dead-ended by wrapping it around the first insulator twice and then giving the end four turns around the line proper close to the insulator; the end of the wire should then be cut off close to the line wire. Where the ordinary tie wire is used it should be 18 inches long, of the same size as the line wire, but for the tie known as the "figure 8" the ties should be cut 22 inches long. In putting on the ordinary tie wire, it is first placed on the opposite side of the insulator from the line wire and the two ends brought around over the line from each side of the insulator and wrapped in a long roll around the line wire. (See fig. 4.)

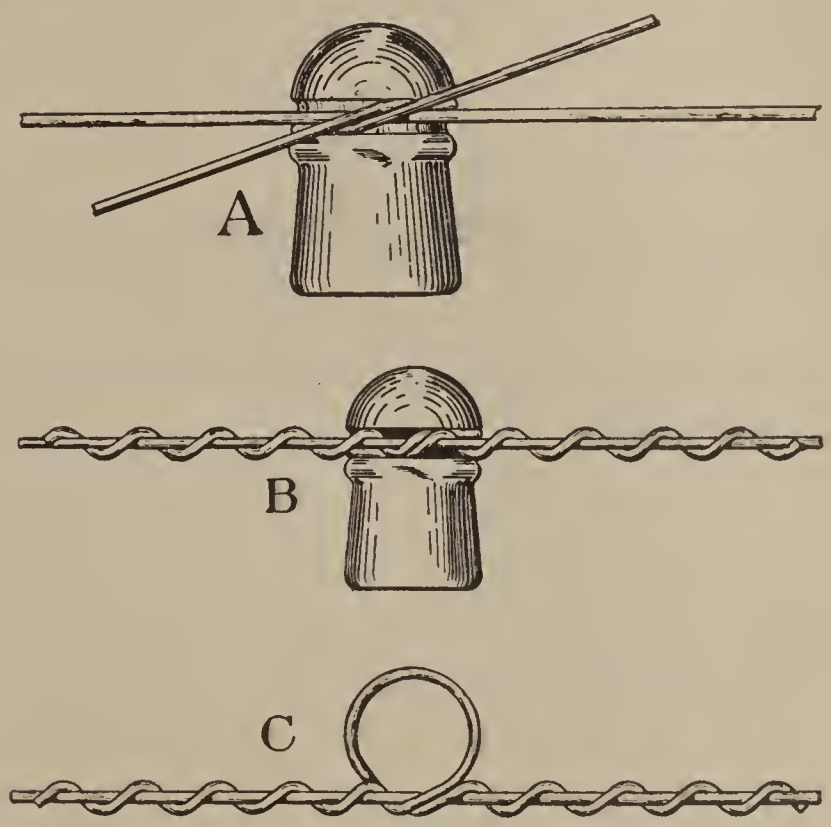

FIG. 4.—Method of tying wire to insulator.

To put on the "figure 8" tie (see fig. 5), it should first be bent in a horseshoe shape just large enough to fit the insulator; it is then put over the line wire, which has been placed in the groove of the insulator, and with the center of the tie wire holding the line wire in the groove the two ends of the tie are brought around the insulator in opposite directions and wrapped in a long roll around the line wire, care being taken not to twist the tie too tight in making the wrap, as it is a very easy matter to burn the line wire; but the tie should be reasonably tight around the wire.

Use of the "figure 8" tie.—The "figure 8" tie should always be used where there are sharp dips or upraises in the line, for at such

places the strain on the wire is often such that the ordinary tie is likely to pull off. When tying in a line that is attached to poles (not trees), and the work is stopped for a short time or at the end of the day, the last tie put on should be a "figure 8." The strain of the wire already up should be held either by the stretcher blocks being left on or by snubbing the wire to the butt of the next pole ahead, in order to prevent any slack running back in the line. This precaution will not be necessary where the wire is put up on trees, as it is expected that there will be a proper amount of slack left in each span between trees as the wire is put up and tied; therefore, no greater amount of strain will come upon the last tie than upon any of the others.

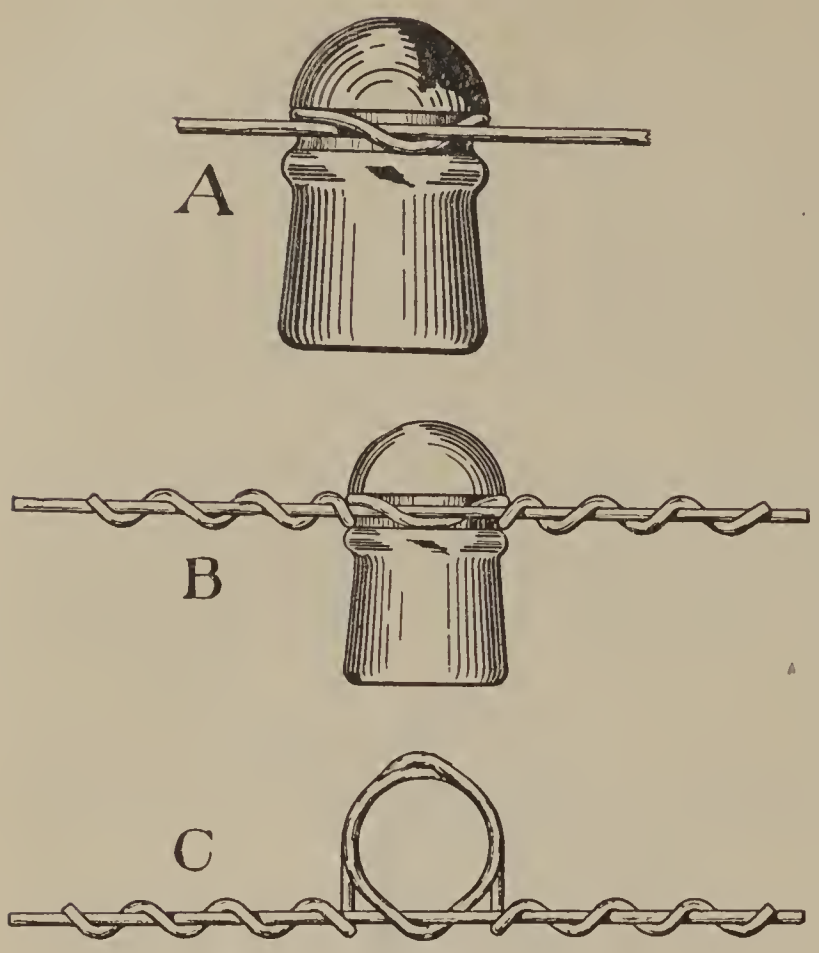

FIG. 5.—Method of putting on "figure 8" tie.

ALLOWANCE FOR SAG.

In tying in a line due care should be taken to allow the proper amount of sag in the wire in each span, keeping in mind the fact that there is much more sag required in spans between a pole and a tree or between two trees than is required between poles, owing to the swaying of the trees. On tree lines never make a span longer than 175 feet, if the trees supporting the wire are not larger than 4 inches in diameter where the bracket is attached.

The following table gives the amount of sag in inches for each span in both pole and tree lines when the wire is tied to glass insulators on brackets.

The sag of wire can be determined by taking the length of span and the temperature at the time of building. In very dry climates, or where there is no great variation in temperature, wire may be strung using the sag given under —10° in the table for pole lines.

Sag of wire when line is strung upon poles.

[Temperatures in degrees Fahrenheit.]

Length of span.	Sag at—							
	−30°	−10°	0	+10°	+30°	+60°	+80°	+100°
Feet.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
100	2	2½	.....	3	3	4½	5½	7
130	3½	4	.....	4½	5½	7	8½	11
150	4½	5	.....	6	7	9	11½	14
175	6	7	.....	6½	9	11½	13	16
200	8	9	.....	10½	12	15½	19	22½
250	12	13	.....	15	17	24	29	34
300	16	17½	20	22½	26	30	36	42
350	20	22	25	29½	35	40	48	54
400	25	30	35½	40	44½	48	56	66
500	36	42	48	54	60	72	82	96

Sag of wire when line is strung upon trees, and tied to insulators on brackets.

[Temperature in degrees Fahrenheit.]

Length of span.	Sag at—							
	−30°	−10°	0	+10°	+30°	+60°	+80°	+100°
Feet.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
100	14	15	.....	16	20	24	30	36
130	16	17	.....	18	22	27	32	38
150	18	19	.....	19	24	29	34	40
175	19	20	.....	22	26	30	36	42
200	20	22	.....	24	31	37	46	54
250	22	.....	30	.....	36	44	52	62
300	26	.....	34	.....	40	50	60	72
350	30	.....	38	.....	51	64	72	92
400	36	.....	42	.....	55	68	78	98
450	42	.....	48	.....	61	74	84	114
500	48	.....	56	.....	72	90	110	132

Swinging insulators.—In the construction of some lines it may be deemed advisable to use a swinging insulator for supporting the wire on trees, but where these are used the line should be tied permanently to a glass insulator on a bracket every quarter of a mile; in some cases, especially on steep mountainsides, every eighth of a mile. The use of the swinging insulator is illustrated in figure 6.

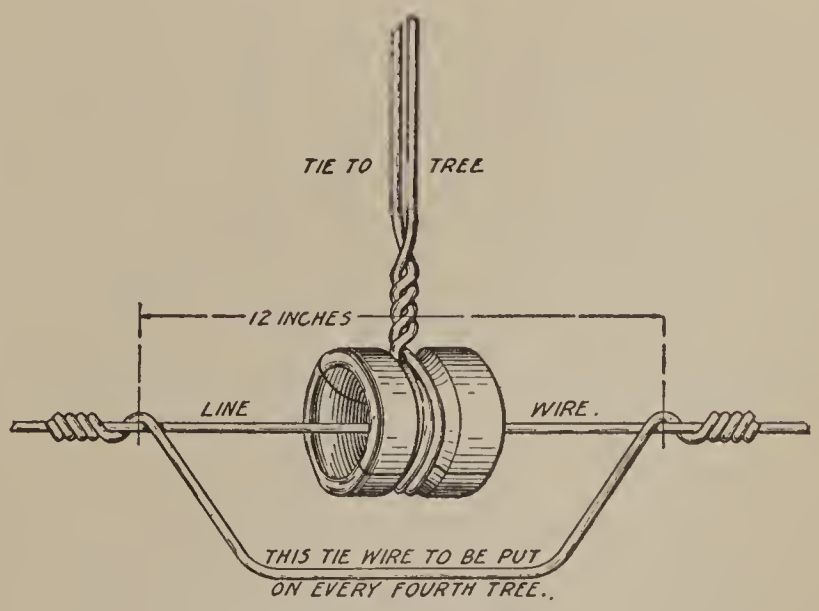

FIG. 6.—Method of preventing line wire from slipping through swinging insulator.

The standard swinging insulator is a two-piece porcelain insulator 2⅞ by 1⅝ inches wide outside diameter. A one-piece insulator or knob should never be used. When these insulators are used, the amount of sag left in each span should

only be half that allowed where the line is tied in on brackets and insulators.

TRANSPOSING OF METALLIC CIRCUIT.

When building a metallic circuit, which is a two-wire line, the wire should be transposed once every mile. But where the line parallels or is close to a high-tension power line, or in altitudes where the static electricity would interfere, it should be transposed at least every tenth pole and oftener, if necessary, to overcome the disturbance of the high potential current of the power line or to overcome the static effect. By transposing is meant the changing of the location of the

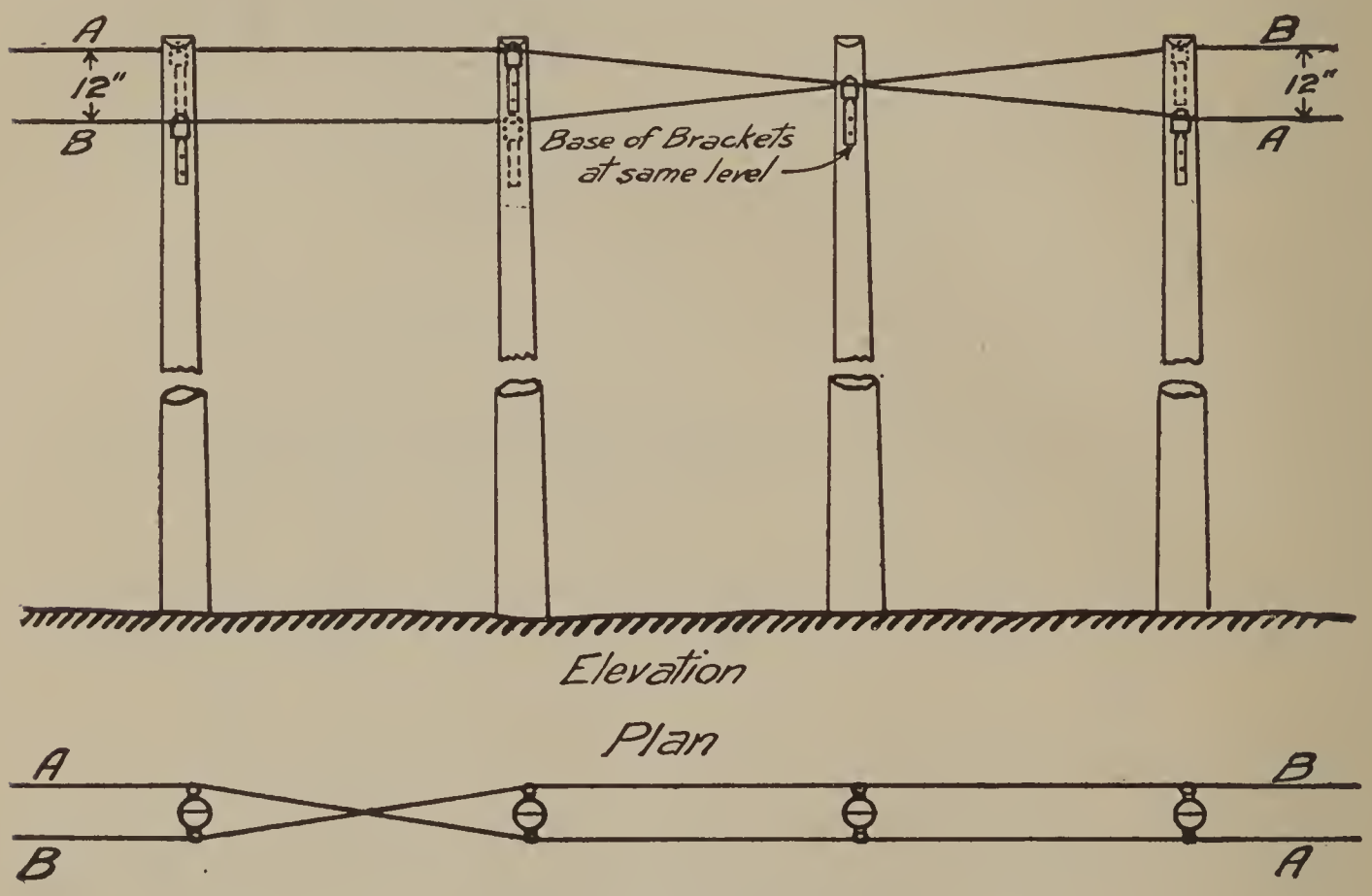

FIG. 7.—Transposition of wires.

wire from one side to the other (see fig. 7), so done that the wires will not touch each other. The rule for transposing telephone lines is to have the wire on the left always cross over the wire on the right; never under it. On a bracket line the transposition can be made very easily by changing the location of the brackets on the pole, as shown by the upper diagram in figure 7. If care is used at the time of stringing the wire, transpositions can be arranged by having the left-hand wire on top of the right at the point where the line is to be transposed. In transposing a line where a cross-arm is used this can best be done by using a two-piece transposition insulator, as the crossing of the wires is then made at the insulator and both wires securely tied in.

CONNECTION OF SERVICE LINES TO OTHERS OR TO AN EXCHANGE.

Whenever it is desirable to connect a Forest Service telephone line with that of a line or an exchange owned or controlled by others, the District Forester should first be advised by letter as to what arrangements, if any, have or can be made for the connection. All conditions under which the connection can be made should be given. All information possible in connection with the matter, such as the length of the Forest Service line and, in cases where it is desired to connect *direct* to another line, the length of such line, the size and kinds of wire used in the construction of both lines, and whether one or both are grounded or metallic circuits, should be given. In addition give the ohm capacity of the instruments on the line with which connection is to be made, also the number of instruments on that line, as well as those on the proposed Forest Service line. The District Forester will then advise as to the best and proper method of handling the matter and making the connections.

INSTRUMENTS.

Where a Forest Service line is to connect direct or be connected by means of switches to another line, the ohms of the ringer coils in the instruments (and extension bells if any are to be used) should be the same capacity as those of the connecting line. The standard capacity of all ringer coils of instruments or extension bells on exclusive Forest Service lines will be 2,500 ohms. There may be cases, however, in connecting with other lines that are already using 1,600-ohm coils, when it will be necessary to use the same capacity coil in the instruments on the Forest Service line.

INSTALLATION.

The proper installation of instruments both on grounded and metallic lines is of much importance and can not be performed with too much care if good service is to be had. In preparing to connect an instrument, except at the two terminal stations, the loop (which means the wire from the line proper to the building where the instrument is to be placed) should first be run, and it is usually desirable to attach this wire to the building by the use of a porcelain knob about $1\frac{3}{4}$ inches long. These knobs should always be attached with a 3-inch No. 16 flathead screw, and *not* with a nail. In bringing the loop wire to the building it should always be run to a point as near the place where the inside wire will come out of the building as is possible. The inside wire should be brought out of the building through a $\frac{3}{8}$-inch hole. This hole should slope upward from without and the wire leading in should have a small drip loop about 2 inches long just before the wire passes into the hole and through the walls of

the building. This prevents any water that may accumulate on the wire outside from running in and causing damage from moisture.

All the instruments are to be properly protected with line fuses and carbon blocks of an approved type, as shown in the standard list.

In attaching the inside wire to the outside line, the connection should be made by the use of an outside-line fuse, one end of which is connected to the line wire and the other to the inside wire leading in to the protector, more commonly called a carbon block. This protector should be placed on the inside of the building and usually near and above the telephone. The single leading-in wire, if it is a grounded circuit that is being connected, is attached to one of the binding posts on the side of the carbon block, but if a metallic line is being connected, then both the leading-in wires are connected with the carbon block, one to each of the binding posts on the side of the block. From these same binding posts two other wires are run and connected to the proper binding posts or mountings in the instrument.

In connecting a grounded circuit, only one wire is run to the instrument from the binding post on the side of the carbon block, and the second wire is attached to the middle (ground circuit) binding post of the carbon block and this wire should also be run to the proper mounting in the instrument. From the middle or ground binding post of the carbon block, whether the line be a grounded or a metallic circuit, there should be an insulated wire run outside of the building through a separate hole in the wall from that of the line wire and connected to the ground.

Ground wires.—One of the great sources of trouble on a grounded telephone line is what is known as a *poor ground.* When installing an instrument on a grounded circuit, it is very essential that a good ground be obtained. Usually a $\frac{1}{2}$-inch galvanized iron rod 5 feet long, when driven to its full length into the ground where there is no rock or gravel, will give the best results, if the earth is damp or moist. Dry earth, gravel, and rock are not good conductors and these are to be avoided. All grounds established must be made in damp or wet places and should be sufficiently deep to reach below the point where the earth freezes in winter or becomes thoroughly dried out in summer. In some cases where the general character of the soil makes it difficult to secure a good ground, a small hand coil of about 50 feet of the same wire that is used for the line, to which is attached the ground wire leading to the instrument, may be thrown into a pool of water, running stream, or well. The connection of the inside wire to the ground rod, when the rod is driven in the ground near the building, may be made by peeling the insulation off the wire for 8 or 10 inches at the end. Then scrape the wire thoroughly clean and bright before it is wrapped around and soldered to the ground rod. Where it is impossible to secure a good ground near the house, the ground wire should be car-

ried to some point near, where a good ground can be established. When this is necessary the ground wire from the building should be the same as that of the line, and should be put up on knobs or brackets, and the outside and inside ground wires connected by twisting and soldering. In attaching the wire to the ground rod, both should be thoroughly brightened and the wire wrapped tightly around the rod and securely soldered. Where the coil of wire is to be grounded in water, enough wire should be allowed to reach to the building where the instrument is placed, for by so doing a splice can be avoided at the coil end. Joints and splices should be avoided.

Fuses.—At each instrument there should be kept a few extra line fuses to replace those burned out. If a fuse is burned out, and a new one is not immediately at hand, the inside wire and the outside line may be connected temporarily; but a new fuse should be secured and put in place as soon as possible.

INSPECTION AND TESTING.

A regular inspection of the whole line should be made every month during the season of fire danger, and two inspections should be made at equal intervals during the remainder of the year. The person making these inspections should follow the line very closely and see that it is in proper place on every pole or tree. He should replace all broken brackets, insulators, and tie wires, and cut all timber which would cause the line to become grounded. The inspector should never pass a station without looking the instrument over carefully to see that there are no loose connections or other defects. He should also call up the terminal and intermediate stations and test the instrument, and note particularly how the generator of the instrument rings its own bells, and how the bells ring at the station called. The called station should ring back in order to test the bells at the calling station. Note the clearness of the voice of the person talking, and find out how distinctly you are heard. In making tests do not take it for granted that something is wrong should you not always get an answer; if unable to raise the station after several attempts, call another station and try to get a test with it. If unable to raise any station on the line the inspector should make a thorough reexamination of the instrument and all connections, carbon block, and ground wire to see if the difficulty is at the calling instrument. Often trouble will be discovered by a second examination.

Special inspections should be made in each district by the ranger, or other officer in charge, immediately after severe wind, snow, or electrical storms, and after fires.

Rangers, Forest guards, and others of the Forest force should examine the line wherever it is encountered during the discharge of their regular duty.

THE MORNING TEST.

One of the first duties in the care of a telephone line is to test it regularly every morning. What is commonly called a *morning test* should be made at an hour fixed by the forest supervisor. On lines over 15 miles long one or more test stations should be established between two terminals to facilitate the work of testing. These test stations should be so arranged that the line may be looped into the house or building where the telephone is, and the connections so made that the line wire passes through two switches placed near the telephone in order that they can be easily and quickly handled by the person making the test. The instrument should be so connected to these switches that it is possible to cut off either end of the line and still keep the instrument on the end desired, and yet bridged to the line when both switches are closed. Thus the line may be cut by the switches when testing, and the trouble more readily located between certain definite points than without the aid of the test stations.

By means of the morning test the trouble will be cleared with much less loss of time than if it were not known until later in the day. Tests may be made for many days before trouble is found, but it is the time when trouble occurs that the value of these morning tests will be appreciated.

Especially during the fire season it is important that every ranger or guard who has a telphone be particularly interested in keeping lines and instruments in thorough working order. It is at this time of the year that the value of the regular morning test should not be underestimated, in order that the greatest efficiency of the lines may be had as an aid in controlling fire.

EMERGENCY REPAIRS.

Each member of the Forest field force should keep on hand at his headquarters, in addition to the necessary tools for repairs, 200 to 300 feet of line wire and a small supply of brackets, insulators, nails, staples, etc., to be used for the temporary repair of breaks. He should always carry a small quantity (10 to 20 feet) of wire while on patrol or inspection duty, in order to make immediate temporary repairs of any breaks.

STANDARD EQUIPMENT.

STATION.

Western Electric Type No. 1317–G telephone complete, with 2,500-ohm unbiased ringer coils.

Western Electric Type No. 1317–F telephone complete, with 1,600-ohm unbiased ringer coils.

Western Electric Type No. 43–J extension bell 2,500-ohm unbiased ringer coils.

Western Electric Type No. 43–A extension bell, special set with 2–F ringer coils (1,600 ohms).

Forest Service test set, special design—for Forest Service work.

Western Electric Type No. 60–A protector.

Western Electric Type No. 6–A outside line fuse.

Western Electric Type Nos. 1 and 2 carbons for 60–A protectors.

Western Electric Type No. 3 protector block micas.

Western Electric style 52108 galvanized-iron ground rods.

Batteries W. E. Co.'s No. 100028 Blue Bell dry batteries; No. 100029 Columbia dry batteries.

Three batteries are required for each instrument and either of the above kind may be used.

FIELD.

Brackets.—Twelve-inch painted oak brackets conforming to specification of the American Telephone and Telegraph Company should be used.

Wire.—Galvanized-iron wire, quality B. B., conforming to specification of the American Telephone and Telegraph Company, should be used, excepting on long spans of over 500 feet, where special instructions from the District Forester should be asked for by the supervisor or man in charge of telephone work.

Insulators.—Line insulators of the type known to the trade as "Standard Pony" insulator, conforming to specification of the American Telephone and Telegraph Company, will be used, except where a line is to be constructed of larger wire than No. 12, when a heavier insulator should be used.

Wire, insulators, and brackets should be requisitioned through the District Forester's office. Authority to purchase locally will be given supervisors only in exceptional cases.

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